

Effect of Central Obscuration on the LDR Point Spread Function

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It is well known that Gaussian apodization of an aperture reduces the sidelobe levels of its point spread function (PSF). In the limit where the standard deviation of the Gaussian function is much smaller than the diameter of the aperture, the sidelobes completely disappear. However, when Gaussian apodization is applied to the LDR array consisting of 84 hexagonal panels, it is found that the sidelobe level only decreases by about 2.5 dB [2]. The reason for this is explained in FIGURE 1a-d.

FIGURE 1a shows the PSF of an array consisting of 91 uniformly illuminated hexagonal apertures; this array is identical to the LDR array, except that the central hole in the LDR array is filled with seven additional panels. For comparison, the PSF of the uniformly illuminated LDR array is shown in FIGURE 1b. Notice that it is already evident that the sidelobe structure of the LDR array is different from that of the full array of 91 panels. FIGURES 1c and 1d show the PSF's of the same two arrays, but with the illumination apodized with a Gaussian function to have 20 dB tapering at the edges of the arrays. While the sidelobes of the full array have decreased dramatically, those of the LDR array changed in structure, but stayed at almost the same level. This result is not completely surprising, since the Gaussian apodization tends to emphasize the contributions from the central portion of the array; exactly where the hole in the LDR array is located.

The two most important conclusions from this work are: (1) the size of the central hole should be minimized, and (2) a simple Gaussian apodization scheme to suppress the sidelobes in the PSF should not be used. A more suitable apodization scheme would be a Gaussian annular ring [2].

References:

1. "Quasi-Optics Modeling Program Applied to the Large Deployable Reflector (LDR)," Jakob J. van Zyl, LDR Technical Memorandum 87-2, JPL Document D-4440, June 1987.
2. "Space Telescope Low-scattered Light Camera: a Model," J. B. Breckinridge et al., Optical Engineering, 23, pp. 816-820.

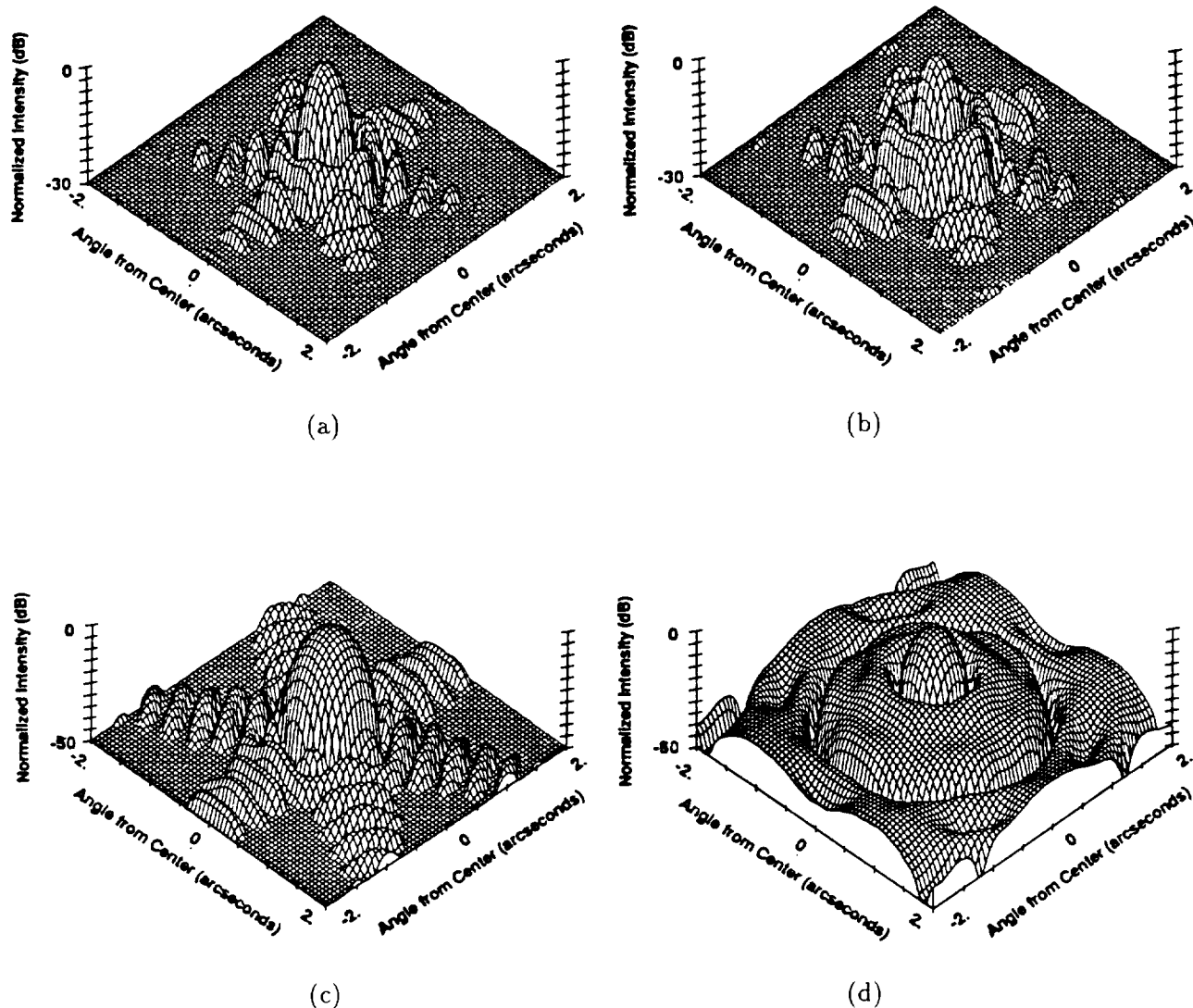


FIGURE 1. (a) Point spread functions for a full array of 91 hexagonal panels with uniform illumination (c) and Gaussian apodization (b) the LDR array of 84 hexagonal panels with uniform illumination (d) and Gaussian apodization. In both cases, the Gaussian apodization is centered on the array and provides 20 dB illumination tapering at the array edges. The psf's were calculated for a wavelength of 30 μm .